ONTARIO

Mercury in Aquatic Macrophytes
Mitchell Bay
Lake St. Clair
1972

MERCURY IN AQUATIC MACROPHYTES

MITCHELL BAY, LAKE ST. CLAIR - 1972

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SUMMARY

During the month of August, 1972, samples of rooted aquatic plants and lake sediments were obtained from Mitchell Bay, Lake St. Clair, and were subsequently analyzed for mercury content to determine the quantity of mercury associated with the plant community and the relationship between the amount of mercury contained in the sediments and that contained in plant material.

The study demonstrated that plant harvesting does not constitute a realistic method of mercury removal in the Mitchell Bay area, mainly because the quantity of mercury associated with the plant material represents a very small portion of total mercury deposits found in the lake sediments.

Mercury deposition in the sediment showed considerable variation with location, despite the generally homogeneous sediment structure in the study area. A detailed study of current patterns and wave action would have to be undertaken in order to clarify deposition patterns.

With the exception of Anacharis canadensis, a poor correlation was found between mercury in the lake sediment and concentrations found in vegetative material.

INTRODUCTION

Following the recent discovery that extensive sections of the St. Clair system and Western Basin of Lake Erie have become contaminated with mercury from industrial sources, considerable emphasis has been placed on possible methods of reclamation, particularly with regard to deactivating or removing mercury - contaminated sediments.

A recent laboratory study by Dollar et al (1971) has demonstrated rapid mobilization of mercury from nutrient solutions and sediments with subsequent incorporation within, or adsorbtion onto, plant material. Varying levels of deposition were observed, depending on the concentrations and characteristics of the Hg carriers. The rapid uptake and resulting high concentrations of mercury in Myriophyllum spicatum demonstrated rooted aquatic plants to be an important link in the uptake and cycling of mercury derived from contaminated sediments. These results also suggested to the researchers that proper harvesting methods may yield appreciable quantities of mercury from contaminated systems.

In order to evaluate the feasibility of mercury removal by mechanical plant harvesting, quantitative surveys of plant densities and mercury levels in rooted aquatics were undertaken in Mitchell Bay, Lake St. Clair.

DESCRIPTION OF STUDY AREA

The survey was limited to a square mile area in Mitchell Bay, known as Cul de Sac, east and north of Fisherman's Island.

The total study area approximated 260 hectares.

The sampling sites were numbered from M1-M20, and with the exception of M17, M18, M19 and M20, all were located on four transects radiating from the northern tip of Fisherman's Island. For further details the map in the Appendix should be consulted.

Physical Parameters

All sampling stations exhibited rather uniform water depths ranging from 1.8 - 2.1 meters.

Although water clarity was generally excellent throughout the study area, somewhat more turbid conditions were observed at stations M5, M6, M7 and M8. The water quality at these stations was closely linked with the periodic conditions in the Chanel Ecarte delta area where increased turbidity is common during periods of extended rainfall.

Perhaps as a direct result of the frequent silt discharges from Chanel Ecarte, elevated mercury levels were found in the lake sediments at these stations.

With the exception of sites M5, M6, M7 and M8, water temperatures remained quite constant throughout the study period, ranging from 24^{o} - $26^{o}C$. Owing to their proximity to Chanel Ecarte somewhat lower readings were obtained at stations M5, M6, M7, M8 (Table 2).

The sediment samples were found to be highly organic, except at station M11, where calcareous materials dominated.

METHODS

All plants and lake sediments were obtained manually while diving. A 1-metre square weighted quadrat frame was used to delineate the area for plant removal and all plant material above the sediment/water interface was harvested. A single quadrat per station was sampled.

To remove excess water, plants were subjected to vigorous shaking followed by periods of air-drying before total biomass was determined by weighing. The wet/dry weight relationships were obtained following forced-air drying of known quantities of the three dominant species: Myriophyllum spp., Anacharis canadensis and Potamogeton spp., constituting 91% of the total biomass removed.

In preparation for mercury analysis the plants were dried in a forced-air oven at 80°C, then total mercury levels were determined by atomic absorption spectrometry after nitric and sulphuric acid digestion at 270°C.

RESULTS AND DISCUSSION

In order to obtain the maximum seasonal biomass, sampling periods were chosen to coincide with the flowering time of most plant species. The dominant species were: Myriophyllum spp., contributing 67% to total standing biomass, followed by Anacharis canadensis with 17% and Potamogeton spp. with 7% (Table 3).

The mean standing plant biomass was found to be 1,834 grams wet, or 219 grams dry weight per square meter. These plant densities would yield approximately 18,340 kilograms of fresh, or 2,190 kilograms of dry plant material per hectare* (Tables 3 and 4).

* 1 Hectare = 2.471 acres.

Spectrometric analysis by species revealed mercury concentrations ranging from non-detectable to 0.41 ppm on a dry weight basis. The weighted mean for all stations and all species was calculated to be 0.09 ppm (Table 5). Further calculations utilizing the mean standing biomass and associated mercury levels indicated that harvesting of a hectare would yield 0.20 grams of mercury, either incorporated or adsorbed to the plant body.

Assuming that mercury concentrations were uniformly distributed throughout the upper 10 centimetres of the sediment layer, total mercury available for methylation would approximate 2,300 grams per hectare. To qualify availability for methylation and turnover of mercury, reference was made to experimental data published by Jernelov (1970).

The results of the field study seem to suggest that mechanical plant harvesting does not constitute a realistic method of reclamation in the mercury-contaminated Mitchell Bay area.

Although the experimental results obtained by Dollar seemed to hold promise for plant harvesting, wide discrepancies in mercury concentrations have made meaningful comparisons with this field study impossible. While the earlier study utilized mercury-contaminated sediments ranging from 46.00 - 460.00 ppm, Mitchell Bay concentrations ranged from non-detectable levels to 4.70 ppm only.

Furthermore, Dollar's work suggested that the most significant role in mercury uptake from sediments was played by organic forms of mercury. This was effectively demonstrated using phenylmercuric chloride, where sediment concentrations of 460.00 ppm produced mercury deposition as high as 219.00 ppm in the plant tissue. In comparison, all six sediment samples analyzed from Mitchell Bay were found to contain less than 0.20 ppb of organic mercury.

Experimental data obtained by Hannerz (1968) suggest that adsorbtion on the plant body is the most significant factor in mercury deposition in contaminated systems. Consequently, plant structure and surface area available for adsorbtion is deemed to have a greater influence on mercury concentrations than contaminant variability in lake sediments.

A statistical analysis was attempted to correlate mercury concentrations in Mitchell Bay sediment with levels found in vegetative material. Of the five species analyzed only Anacharis canadensis exhibited a significant positive correlation at the 95% confidence levels.

REFERENCES

DOLLAR, S.G. 1971 D.R. Keeney and G. Chesters, Mercury Accumulation by Myriophyllum spicatum L. Environmental Letters, 1(3): 191-198.

HANNERZ, L. 1968. Experimental Investigations on the Accumulation of Mercury in Water Organisms. Institute of Freshwater Research, Drottningholm, Report No. 48: 119-176.

JERNELOV, A. 1970. Release of Methyl Mercury from Sediments with Layers Containing Inorganic Mercury at Different Depths. Limnology and Oceanography V15(6): 958-960.

A P P E N D I X

Fig. 1 Map of study area Mitchell Bay

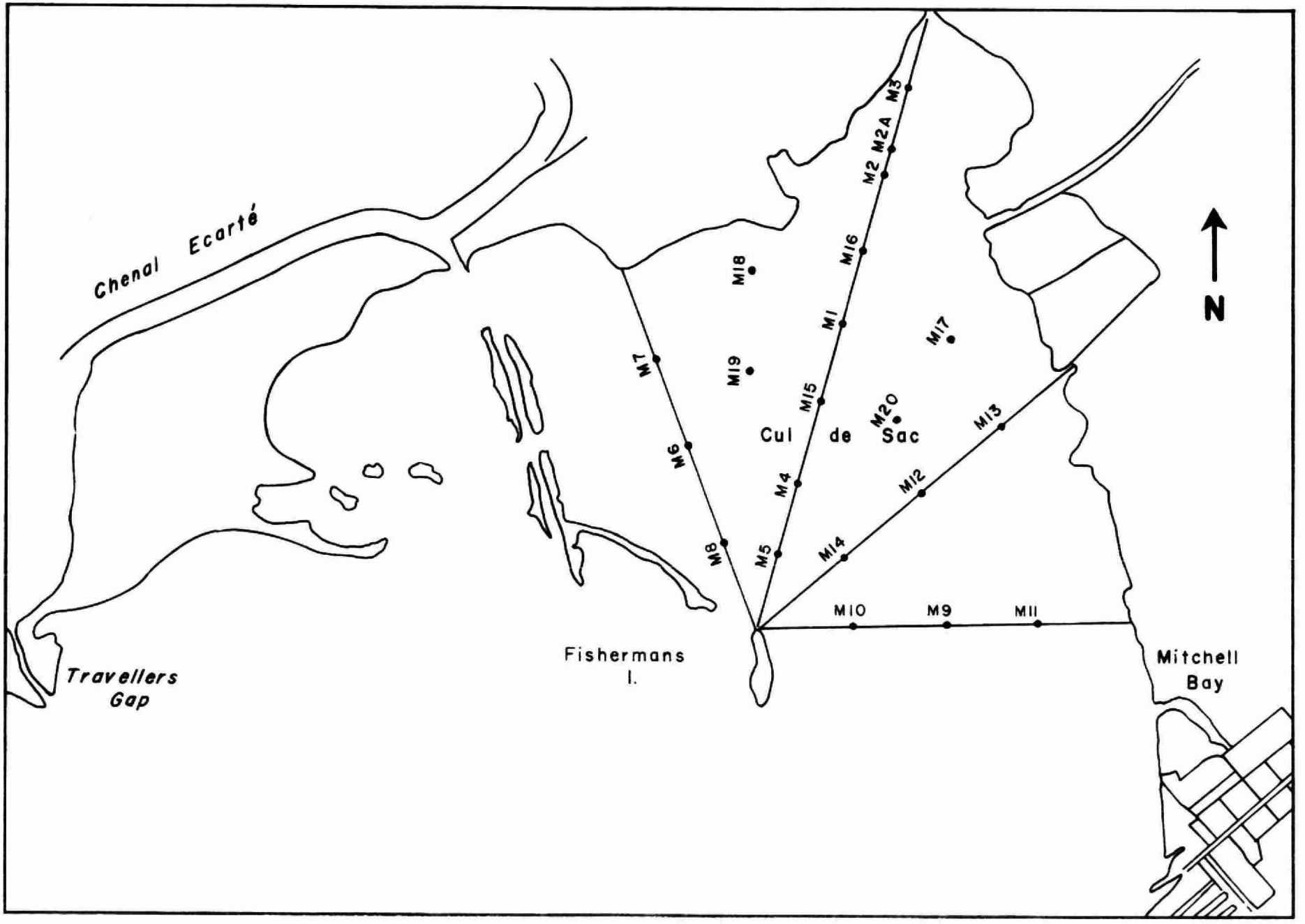

TABLE 2: Physical Parameters of Sampling Area, Mitchell Bay, 1972.

Sampling Station	Depth in Meters	Water Temperature C°	Secchi Disc
M1	1.8	25	1.8
M2	1.8	25	1.8
M2A	1.8	25	1.8
M3	1.8	25	1.8
M4	2.0	24	2.0
M5	2.0	23	2.0
M6	1.8	21	1.5
M7	1.8	21	1.5
M8	2.0	22	1.5
M9	2.1	24	2.1
M10	2.0	24	2.0
M11	1.5	24	1.5
M12	1.8	25	1.8
M13	2.0	25	2.0
M14	2.0	25	2.0
M15	2.0	25	2.0
M16	1.9	25	1.9
M17	1.8	26	1.8
M18	1.8	26	1.8
M19	2.0	26	2.0
M20	2.0	25	2.0

TABLE 3: Standing Biomass of Aquatic Macrophytes, Mitchell Bay, 1972.
(All values in grams per square metre)

Sampling Station	Myriophyllum spp.	Anacharis canadensis	Potamogeton crispus	Potamogeton richardsonii	Potamogeton vaginatus	Ceratophyllum spp.	Vallisneria americana	Scirpus Validus	Chara spp.	Cladophora spp.	TOTAL
M1	2435	28			28						249
M2	821	28			28						87
M2A	2152						283				243
M3	1132	113			57	679					198
M4	1246	57	28								133
M5	425	113			28	28		57			65
M6		1217	85		28	57					138
M7		85	1076		28	85					127
M8		368	679		226						127
M9	1812										181
M10	1132	481			28	28					166
M11	28	85					28		170		31
M12	2519	42			42	42					264
M13	849	1954			28	538					336
M14	1189	510				255					195
M15	2123										212
M16	2775				28	28					283
M17	963	57								736	175
M18	425	1274				255					195
M19	1953						57				201
M20	1897	57		425							237
Total	25,876	6469	1868	425	549	1995	368	57	170	736	38,51
% Contribution	67	17	5	1	1	5	1			2	100

Fig. 4 Total mercury in aquatic vegetation
Mitchell Bay - 1972

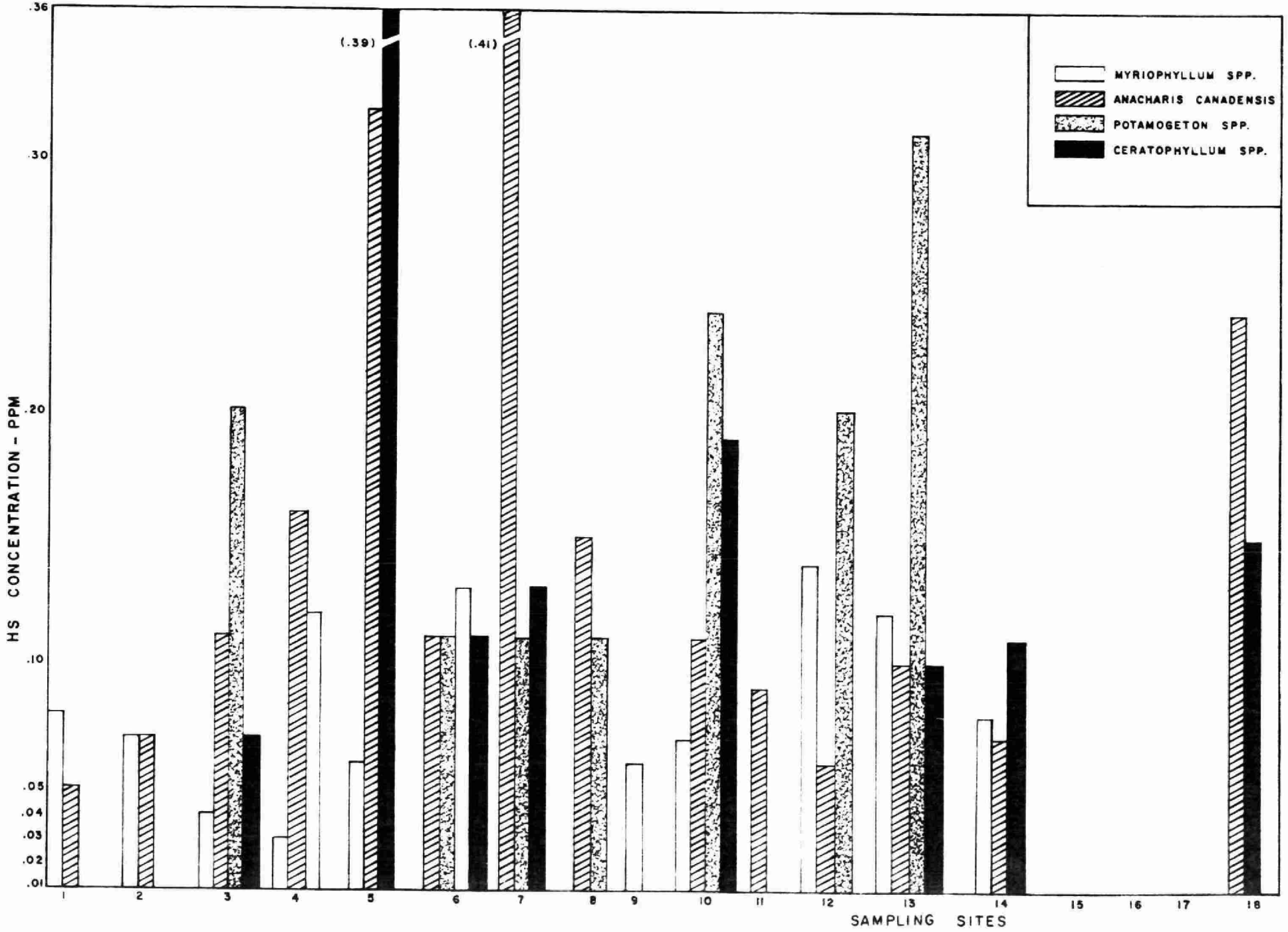

TABLE 5: Mercury Levels in Aquatic Macrophytes and Lake Sediments, Mitchell Bay, 1972.

Sampling Stations	MERCURY CONCENTRATIONS - ppm					
	Sediments	Myriophyllum spp.	Anacharis Canadensis	Potamogeton spp.	Ceratophyllum spp.	Vallisneria americana
1M	1.90	0.08	0.05			
2M	0.74	0.07	0.07			0.07
3M	1.20	0.04	0.11	0.20	0.07	0.09
4M	2.80	0.03	0.16			
5M	4.70	0.06	0.32		0.39	
6M	4.00		0.11	0.12	0.11	
7M	2.90		0.41	0.11	0.13	
8M	2.90		0.15	0.11		
9M	1.10	0.06				
10M	0.31	0.07	0.11	0.24	0.19	
11M	0.06		0.09			0.07
12M	0.18	0.14	0.06	0.20		
13M	1.34	0.12	0.10	0.31	0.10	
14M	0.46	0.08	0.07		0.11	
15M	0.90					
16M						
17M	1.04	N.D.				
18M	0.91	N.D.	0.24		0.15	
19M						
20M						

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